The Influence of Type of Poultry and Carcass Part on the Extractability and Emulsifying Capacity of Salt-Soluble Proteins[1]

A. J. MAURER, R. C. BAKER AND D. V. VADEHRA
Department of Poultry Science, Cornell University, Ithaca, New York 14850

(Received for publication November 11, 1968)

CHICKEN products such as chicken franks, chicken bologna, chicken chunk roll, and other convenience items are finding their place among today's new foods. In all of these emulsion products, the type of meat protein used is important. According to Swift *et al.* (1961) salt-soluble proteins are more effective for preparing emulsions than those proteins extractable by water. Saffle and Galbreath (1964) stated that pH of the meat has a significant effect on the amount of salt-soluble protein which can be extracted; as pH was increased, the amount of protein extracted increased. These same workers also discovered that the freezing of beef reduced the amount of salt-soluble protein extracted, when compared to unfrozen beef 48 hours post-mortem.

Carpenter and Saffle (1964) showed that the amount of salt-soluble protein in the original aliquot used, the speed of mixing, the final temperature of the emulsion, and the amount of oil added initially, influenced the emulsifying capacity of the protein.

Hudspeth and May (1967) found that total protein and salt-soluble protein was significantly greater in amounts in light meat as compared to dark meat in the same type of poultry.

This study was conducted to determine the amount of salt-soluble protein and its emulsifying capacity as influenced by: a) type of poultry (light and heavy fowl, broilers and mature turkeys) and b) carcass part (total carcass, leg, thigh, breast, neck, gizzard and skin).

[1] This investigation was supported by N. I. H. Training Grant No. UI 01032 from Environmental Sanitation.

MATERIALS AND METHODS

The meat used in this study consisted of leg, thigh, breast, neck, gizzard, skin and total carcass of light fowl (White Leghorns—15 months lay), heavy fowl (White Plymouth Rock—12 months lay), broilers (White Cornish × White Plymouth—8 weeks of age), and turkeys (Empire Whites—24 weeks of age). All of the poultry used was from the Cornell University poultry farm. The carcasses were deboned, the meat was ground three times through a 1/8 inch plate and thoroughly mixed. The salt-soluble proteins were extracted and the emulsifying capacity was determined on the extracted proteins. All data were analyzed by factorial analysis of variance using a CDC 1604 computer.

Salt-Soluble Protein. Total protein content was determined by the Kjeldahl procedure. The salt-soluble proteins were extracted by a method similar to that of Saffle and Galbreath (1964). Twenty-five grams of fresh ground meat was blended for one minute with 150 ml. of 3% sodium chloride in as Osterizer at 10,000 rpm. The mixture was allowed to stand for two minutes and then blended for an additional minute. The meat slurry was centrifuged at 26,000 × G for fifteen minutes in a cold room (1.5°C.). The protein concentration of the supernatant was determined by the Biuret method (Gornall *et*

al., 1949). The salt-soluble protein was expressed as grams per 100 grams of meat and as percent of total protein.

Emulsifying Capacity Determination. Forty ml. each of salt-soluble protein extract and cottonseed oil were placed into an Osterizer jar. The mixture was emulsified at 10,000 rpm. for 15 seconds before adding oil from a buret through Tygon tubing at a rate of 1.1 ml. per second. The addition of oil was continued until an abrupt change in viscosity was seen. The end point temperature was checked on every sample. All emulsions were produced at the same temperature. The emulsifying capacity of the salt-soluble protein extract was expressed as ml. of oil emulsified by 100 mg. of salt-soluble protein.

RESULTS AND DISCUSSION

Type of Poultry. The amount of salt-soluble protein extracted from light fowl, heavy fowl, broilers and turkeys is shown in Table 1. On the basis of total carcass, the highest amount of salt-soluble protein per 100 grams of meat was extracted from the heavy fowl followed by turkeys, light fowl and broilers. Analysis of variance (Table 4) showed that the differences in salt-soluble proteins from different types of poultry is highly significant. The same trend was observed when salt-soluble protein concentration was expressed as percent of total protein (Table 2). The amount of oil emulsified by salt-soluble protein however, was drastically different, the broiler meat which contained the lowest amount of salt-soluble protein per 100 grams of meat emulsified the greatest amount of oil per unit weight of protein. Heavy fowl which had the highest total amount of salt-soluble protein emulsified the least amount of oil on a unit basis.

Carcass Part. The influence of carcass part on the quantity of salt-soluble proteins can be found in Table 1. The skin had the lowest quantity of salt-soluble protein while the gizzard had the highest. Hudspeth and May (1967) reported that the light meat contained higher amounts of salt-soluble protein as compared to dark meat within the same type of poultry. These data (Table 1) agree in part with those reported by Hudspeth and May (1967) in that the breast meat of the different types of poultry contained more salt-soluble protein than the leg or thigh. Gizzard, however, contains considerably more salt-soluble protein in all types of poultry studied. Neck meat contained more salt-soluble protein that the breast in the older poultry (light and heavy fowl) but with the younger poultry (broilers and turkeys) breast meat contained more salt-soluble protein than the neck. Analysis of variance (Table 4) shows that the differences in the salt-soluble protein content of various carcass parts are highly significant.

As shown in Table 2, the carcass parts with low salt-soluble protein also produced low values when the salt-soluble protein concentration was expressed as a percent of the total protein. It has been shown by Saffle and Galbreath (1964)

TABLE 1.—*Grams of salt-soluble protein per 100 grams of the respective bone free carcass part. (Values are average of four replications)*

	Salt-soluble protein (g.) 100 g. meat			
Carcass part	Light fowl	Heavy fowl	Broiler	Turkey
Leg	5.92	5.00	5.23	6.50
Thigh	8.05	6.18	5.90	6.78
Breast	7.80	7.42	7.98	7.65
Neck	8.00	11.85	5.60	5.93
Gizzard	10.75	18.75	13.23	13.48
Skin	1.65	2.20	3.77	5.28
Total carcass	7.80	9.98	5.70	8.50

TABLE 2.—*Salt-soluble protein concentration expressed as percent of total protein over the seven carcass parts studied. (Values are averages of four replications)*

Carcass part	Salt-soluble protein concentration×100 / Total protein concentration			
	Light fowl	Heavy fowl	Broiler	Turkey
Leg	28.60	26.20	24.62	33.00
Thigh	44.45	33.20	30.25	33.58
Breast	33.92	31.68	33.38	34.35
Neck	40.90	82.85	30.45	30.65
Gizzard	68.05	81.54	76.35	70.80
Skin	17.20	17.30	25.75	46.80
Total carcass	41.82	56.12	28.55	41.90

that skeletal and cardiac muscles contain considerably more salt-soluble protein than smooth muscle meat.

The extracts obtained from various carcass parts were used for the production of emulsions. A uniform quantity, 40 ml. of each extract was used and it was observed that the amount of oil emulsified with 40 ml. of the extract varied with different parts, being highest for gizzard and lowest with skin. This observation is in agreement with the research reported by Maurer and Baker (1966), in which the high collagen content was cited as the contributing factor. However, when the amount of oil emulsified was expressed in terms of 100 mg. of salt-soluble protein instead of 40 ml. of the extract, it was observed that the skin which had to lower the amount of protein in the extract emulsified greater amounts of oil per 100 mg. of salt-soluble proteins (Table 3). Swift *et al.* (1961) reported a similar relationship between concentration and emulsifying capacity of bovine muscle.

TABLE 3.—*Milliliters of oil emulsified per 100 mg. of salt-soluble protein from respective carcass parts. (Values are averages of four replications)*

Carcass part	Ml. oil emulsified / 100 mg. salt-soluble protein			
	Light fowl	Heavy fowl	Broiler	Turkey
Leg	23.07	20.00	29.90	21.43
Thigh	15.37	18.08	24.25	20.70
Breast	19.18	20.40	21.98	17.65
Neck	14.52	9.62	24.02	23.85
Gizzard	11.23	8.80	13.40	12.70
Skin	54.35	33.95	36.45	18.40
Total carcass	14.72	11.75	25.73	16.25

SUMMARY

An investigation was made with poultry meat to determine the influence of type of poultry, and carcass part on the amount and emulsifying capacity of extracted salt-soluble proteins. Carcass parts yielding high concentration of total salt-soluble protein generally emulsified the least amount of oil when data were expressed on a unit quantity of protein, suggesting that an inverse relationship exists between concentrations and emulsifying efficiency.

Broiler meat generally emulsified the most oil per 100 mg. of salt-soluble protein. Meats such as leg, and breast with lower salt-soluble protein concentrations expressed as percent of total protein are probably better for emulsifying meats because of the higher total protein concentrations. An analysis of carcass parts and kinds and classes of poultry on a fresh meat basis will give a better indication of the worth of meats as emulsion stabilizers.

REFERENCES

Carpenter, J. A., and R. L. Saffle, 1964. A simple

TABLE 4.—*Analysis of variance of amounts of salt-soluble protein extracted from poultry meat*

Source of variation	df	SS	MS	F
A (Carcass part)	6	1,047.84	174.64	57.08**
B (Type of poultry)	3	63.82	21.27	6.95**
AB	18	258.60	14.37	4.70**
Error	84	6,729.16	3.06	
Total	111	8,099.42		

** Significant at the 1% level of probability.

method of estimating the emulsifying capacity of various meats. J. Food Sci. 29: 774–781.
Gornall, A. G., C. J. Bardawill and M. M. David, 1949. The determination of protein by the biuret method. J. Biol. Chem. 177: 751–766.
Hudspeth, J. P., and K. N. May, 1967. A study of the emulsifying capacity of salt-soluble proteins of poultry meat. Food Technol. 21: 1141–1142.
Maurer, A. J., and R. C. Baker, 1966. The relationship between collagen content and emulsifying capacity of poultry meat. Poultry Sci. 45: 1317–1321.
Saffle, R. L., and J. W. Galbreath, 1964. Quantitative determination of salt-soluble protein in various types of meats. Food Technol. 18: 1943–1944.
Steel, R. G. D., and J. H. Torrie, 1960. Principles and Procedures of Statistics. McGraw-Hill Book Company, Inc., New York, N. Y.
Swift, C. E., C. Lockett and A. S. Fryar, 1961. Comminuted meat emulsions—the capacity of meats for emulsifying fat. Food Technol. 15: 468–473.

The Influence of Environmental Temperature on the Plasma Proteins of Domestic Fowl[1]

TILL M. HUSTON AND TATA SUBHAS
Division of Poultry Science, University of Georgia, Athens, Georgia 30601

(Received for publication November 14, 1968)

VARIOUS hormones such as thyroxine, corticoids and perhaps insulin circulate in the blood stream bound to certain fractions of the plasma proteins. However, the factors which regulate the concentration of plasma proteins are not clearly understood. There is evidence that various physiological, pathological and environmental factors are involved. Gordon *et al.* (1952) reported that the thyroid hormones are carried in the blood stream bound to a specific protein. Skin irritants, certain poisons, hemorrhage, fractures of bones and injury cause an increase in the protein globulins of humans (Putnam, 1960). Changes in body temperature may cause a shift in tissue fluids and thus cause a change in the concentration of plasma proteins (Sturkie, 1965). Globulins are associated with the production of antibodies. Chickens are good producers of antibodies and this is related to the higher ratio of globulins to albumen in chicken blood (Wolfe *et al.*, 1957).

It is generally accepted that environmental conditions influence hormonal activity of the thyroids, adrenals and the gonads.

The present experiment was designed to determine if environmental temperature influenced the characteristics of the plasma proteins in domestic fowl.

PROCEDURE

The mean temperature of the three environments studied were 8°, 19°, and 30°C. with a diurnal cycle of 4°–12°, 15°–23°, and 26°–34°, respectively. The birds used were White Plymouth Rock cockerels that had been grown from day of hatch in one of the respective environments. Thirty-four of the cockerels were selected from 19°C. and twenty-six birds were selected from each of the other two environments. When the birds were 20 weeks of age the initial blood samples were collected and then eight birds from each environment were transferred to

[1] University of Georgia College of Agriculture, Experiment Stations Journal Series Paper 400, College Station, Athens, Georgia 30601.